DESY
MPL, MHF-sl

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Lab-Note 1/96
(Version E)

Technical Specification for Niobium Applied for the Fabrication of 1.3 GHz Superconducting Cavities RRR 300

W. Singer, D. Proch

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1. Electrical Properties

1.1 RRR values: guaranteed min RRR 300*
aim RRR > 300

*The residual resistivity ratio RRR is defined as the ratio of electrical resistivity at 295K to electrical resistivity at 4,2K

2. Chemical Composition

The ingot meets the chemical analysis for following elements

Content	guaranteed
Ta	≤ 0.05 %
W	≤ 0.007 %
Ti	≤ 0.005 %
Fe	≤ 0.003 %
Si	≤ 0.003 %
Mo	≤ 0.005 %
Ni	≤ 0.003 %

Content of interstitial elements in the annealed Nb

Content	guaranteed
H_2	≤ 2 ppm
N_2	≤ 10 ppm
O_2	≤ 10 ppm
C	≤ 10 ppm

Measurements according to 5

3. Mechanical Properties

3.1 Sheet material in deep drawing quality

Deep draw quality and avoidance of orange skin has to be demonstrated on samples (for example by bending with r = 10 mm, small radius at iris).

3.2 Grain size

The material exhibits a completely recrystallized structure.
The following grain size in the sheet material is expected:

- Grain size ASTM # 6 or finer
- Local grain sizes ASTM 4-5

3.3 Mechanical properties at room temperature (DIN50145/50125/50133)

tensile strength, Rm	> 140 N/mm^2 *
0.2 % nonproportional elongation, $R_{p0,2}$	50<$R_{p0,2}$<100 N/mm^2 *
percentage elongation after fracture using min 30 mm gauge length, AL30	≥ 30 % *
hardness, HV 10	≤ 60

*measured both orthogonal and parallel to main rolling direction using a strain rate ca. 10^{-3} sec^{-1}. The difference in mechanical properties (Rm, $R_{p0,2}$, AL30) measured orthogonal and parallel to main rolling direction should not exceed 20%.

4. Quality of Final Product

Clean conditions during fabrication, especially during rolling, are crucial. Therefore DESY wants to discuss with the vendor fabrication methods in regard to cleanliness.

4.1 Sheets have to meet the following specifications after final annealing and cleaning (global removal of about 10 µm by grinding followed by a chemical surface treatment of about 10 µm):

4.1.1 RF side (have to be marked on back by writer):
a) free from defects according to 7.1 this specification,
b) surface roughness Rt ≤ 15 µm.

4.1.2 Back side:
a) free from defects according to 7.1 this specification,
b) scratches and hollows are acceptable below 60 µm if free from non niobium material,
c) defects have to be marked by writer.

4.1.3 Bulk Niobium
Sheets should be free of defects inside the niobium (7.2). Laminations can be detected by ultrasonic measurements, whereas smaller defects are difficult to locate. The vendor is asked to discuss appropriate measurement techniques. DESY suggests to use a scanning eddy current method to determine cracks, laminations, inclusions etc. of blank sheets. The apparatus can be supplied and operated by DESY. Calibration will be done with "bad" samples (supplied by DESY).

4.2 Tolerances

4.2.1 Dimension of sheets

2.8 ± 0.1 mm x 265 ± 1 mm x 265 ± 1mm

4.2.2 Surface flatness according to ASTM B708: 2 % or better

5. Measurements

Certificates for Nb should include the following measurements and checks of the properties specified in section **1-4**:

5.1 Sheet material

5.1.1 Check of dimensions and rolling laminations. Sample size according to DIN ISO 2859-1, test level 2.
5.1.2 HV has to be measured after final annealing for each sheet.
5.1.3 For each annealing charge two samples (min HV, max HV) have to be measured for:
- RRR
- R_m
- $R_{p0,2}$
- AL30
- grain size
- gas content.

5.1.4 Chemical analysis.

5.2 Ather RRR300 but not sheet material:

- check of dimensions
- RRR
- gas content
- prove the complete recrystallization

5.3 Metallic contaminants and RRR shall be measured on each ingot.

6. Accepting and Packing

6.1 DESY personnel will visually inspect the material at the plant of fabrication.
6.2 DESY intents to examine the sheet by eddy current scans (4.1.3). At the present state of this technology no material will be rejected hereby.
6.3 Packing, particularly of the RF side, has to be made in such a way that no defects as described in point 7.1, this specification, will occur during transportation.
6.4 Packing and shipping is done at the contract holder's (manufacturer's) risk.
6.5 Final acceptance will take place at the final destination upon a visual inspection for defects caused by packing and/or shipping.

7. Defects

7.1 Definition of standard defects (to be removed from the surface)

7.1.1 Non niobium material.
7.1.2 Visible clusters from niobium oxides, segregation, cracks, blisters.
7.1.3 Scratches and marks of more than $R_t \geq 15$ µm for the RF side or of $R_t \geq 60$ µm for the back side, even if free from non niobium material.
7.1.4 Grease and finger prints on the surface.

7.2 Standard defects inside the niobium bulk

7.2.1 Shrink holes, laminations and cracks.
7.2.2 Niobium oxide and non niobium clusters.